NWP SAF

AAPP Version 7 Product Specification

Version 1.0

21st Oct 2011

AAPP Version 7 Product Specification

This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 1st December 2006, between EUMETSAT and the Met Office, UK, by one or more partners within the NWP SAF. The partners in the NWP SAF are the Met Office, ECMWF, KNMI and Météo France.

Change record				
Version	**Date**	**Author**	**Approved**	**Remarks**
0.1	27/06/2007	N C Atkinson	-	Initial draft
1.0	21/10/2011	N C Atkinson	B J Conway	

Table of Contents

1. INTRODUCTION

This document defines the specification for Version 7 of the ATOVS and AVHRR Pre-processing Package (AAPP), in accordance with the requirements of the NWP SAF. The Product Specification describes the deliverable from the point of view of the user.

It concentrates on those aspects of AAPP that are new in version 7 – for more details on the specification of previous versions of AAPP, see RD-6.

1.1 Reference documents

[RD-1] NWPSAF-MF-UD-001, AAPP Documentation Scientific Description
[RD-2] NWPSAF-MF-UD-002, AAPP Documentation Software Description
[RD-3] NWPSAF-MF-UD-003, AAPP Documentation Data Formats
[RD-4] NWPSAF-MO-UD-004, AAPP Overview
[RD-5] NWPSAF-MO-UD-005, AAPP Installation Guide
[RD-6] NWPSAF-MO-DS-010, AAPP Version 6 Product Specification
[RD-7] NWPSAF-MO-UD-027, Annex to AAPP scientific documentation: Pre-processing of ATMS and CrIS

2. PURPOSE

AAPP is a pre-processing package for use with infra-red and microwave satellite sounder data and with visible/IR imager data. It is developed and maintained by the NWP-SAF. AAPP is currently capable of processing data from the NOAA and MetOp series of polar-orbiting satellites and from FY-1D.

AAPP version 7 is additionally required to process data from the NPOESS Preparatory Project (NPP). The additional functionality will also be applicable to follow-on JPSS satellites.

3. FUNCTIONALITY

AAPP v7 will provide all the functionality of previous versions of AAPP. For NOAA and MetOp satellites it will be backward compatible in terms of user operation, input data and output data – as described in RD-1, RD-2, RD-3 and RD-4.

AAPP currently provides the following main functions:

- Ingest HRPT data files from the NOAA, MetOp and FY-1D polar orbiting satellites.
- Calibrate and Earth locate the ATOVS and AVHRR instrument data (or TOVS and AVHRR data in the case of pre-NOAA-15 satellites[1]). The ATOVS instruments comprise AMSU-A, AMSU-B (or MHS) and HIRS. The TOVS instruments comprise MSU and HIRS.
- Calibrate and Earth locate the AVHRR-like channels on FY-1D MVISR.
- Level 1 processing for IASI (via the add-on package OPS-LRS)

[1] AVHRR calibration is provided from NOAA-11 onwards; HIRS and MSU from NOAA-9 onwards.

- Pre-processing of ATOVS instruments to convert to level 1c (radiance) and level 1d (instruments mapped to a common grid).
- AVHRR cloud mask on HIRS grid
- Pre-processing of IASI, including mapping AMSU/MHS to IASI, spectral thinning (including Principal Components) and spatial thinning.
- Ingest level 1b AMSU, MHS and HIRS files from NOAA (e.g. from the CLASS archive).
- Ingest level 1c BUFR files for AMSU, MHS, HIRS and IASI (e.g. from EUMETCast).
- For AVHRR, convert between level 1b "PFS format" and AAPP format.

The additional top-level functions to be provided in version 7 are listed below:

1. Ingest Sensor Data Records (SDRs) from ATMS, CrIS and VIIRS on NPP (see note 1 below)
2. Ingest BUFR files from ATMS and CrIS, using the BUFR definitions defined by NOAA and approved by WMO.
3. Map ATMS to CrIS
4. Spatial averaging of ATMS (see note 2 below)
5. Spectral and spatial thinning of CrIS (as for IASI)
6. Upgrade the MAIA cloud mask to MAIA v4, supporting VIIRS. This upgrade is planned as a day-2 activity.
7. Ingest Sensor Data Records from the Microwave Temperature Sounder (MWTS) and Microwave Humidity Sounder (MWHS) on FengYun-3 satellite series, and map MWHS to MWTS.

Note 1: AAPP will *not* accept raw direct readout data for NPP. The user will be expected to run an external processing package to generate the SDRs, or alternatively to download the SDRs from an external archive (e.g. CLASS). The SDRs will be in HDF-5 format. Currently both NASA and University of Wisconsin are developing level 1 processing packages for NPP direct readout; these are the *International Polar Orbiter Processing Package* (IPOPP) and the *Community Satellite Processing Package* (CSPP) respectively, both based on the Raytheon *Algorithm Development Library* (ADL).

Note 2: It is assumed that the ATMS SDRs contain all channels at the original sampling distances (1.11º cross-track, 8/3 sec per scan). The lower frequency channels (below 89GHz) have beam widths that are much broader than the sampling distance and must be averaged to achieve acceptable noise performance. The beam widths are 2.2º at 50-57 GHz and 5.2º at 23.8 and 31.4 GHz.

Addition of other satellites in an existing series (e.g. MetOp-B) will be done through the normal AAPP update process and will not necessarily correspond with a new major release.

4. SOFTWARE ORGANISATION

Some of the required libraries, notably the HDF-5 and BUFR libraries and IPOPP/IMAPP, will be external to AAPP and the user will be expected to download them separately in order to run those parts of AAPP that depend on them.

The remaining NPP- and JPSS-specific components will be integrated within the existing AAPP structure.

5. INPUTS / OUTPUTS

5.1 Existing AAPP v6

The script AAPP_RUN_NOAA is intended for processing HRPT from NOAA satellites. It takes the following inputs:

- HRPT data file
- Navigation data (tbus or 2-line element)

and generates the following primary output products:

- Level 1d output file containing AMSU-A, AMSU-B (or MHS), HIRS and AVHRR instruments mapped to HIRS grid, or AMSU-A and AMSU-B mapped to the AMSU-A grid or AMSU-B grid.
- Level 1b and 1c files for AMSU-A, AMSU-B (or MHS), HIRS
- Level 1b file for AVHRR

Similarly, the script AAPP_RUN_METOP takes the following inputs:

- MetOp level 0 files
- Navigation data (or HKTM level 0)

and generates level 1b, 1c and 1d outputs for AMSU-A, MHS, HIRS and AVHRR.

The script AAPP_RUN_FY1 takes the following inputs:

- CHRPT data for FY-1D
- Navigation data (tbus or 2-line element)

and generates level 1b for MVISR (AVHRR-like channels only).

The data levels 1a, 1b, 1c and 1d are defined in RD-3.

By running individual components of AAPP (e.g. amsuacl, amsubcl, hirscl, atovin, atovpp) it is possible to take level 1a, 1b or 1c as input. This includes AMSU, MHS and HIRS level 1b files from NOAA/NESDIS. AVHRR 1b files from NESDIS (LAC/HRPT) require format modifications before they can be processed by AAPP – see [RD-3].

AAPP will automatically detect the endian-ness of the input data; output data will be in the native byte order of the platform.

A tool is available to convert level 1c AMSU-A, AMSU-B, MHS, HIRS and IASI from BUFR (e.g. delivered via EUMETCast) to AAPP format – ready for input to atovpp. A tool is also available to convert 1c AAPP format to BUFR.

For AMSU-A, AMSU-B and MHS, the input level 1c files may either be antenna-corrected or not antenna-corrected; a tool is provided in AAPP to apply and/or remove antenna corrections as required.

5.2 AAPP v7

In addition to the inputs of AAPP v6, AAPP v7 is required to accept the following inputs:

- Sensor Data Records in HDF5 format for ATMS, CrIS, MWTS and MWHS. VIIRS will be added later via an update release.
- Sensor Data Records in BUFR format for ATMS and CrIS

Additional outputs will be as follows:

- Level 1d ATMS and CrIS, on the full-resolution CrIS grid (9 samples per step, 30 steps per 8-second scan). The number of CrIS spectral samples and/or Principal Components scores will be user-configurable.
- Level 1d ATMS and CrIS, on a reduced resolution CrIS grid (1 sample per step)
- Level 1d ATMS on an AMSU-A-like grid (32 samples per 8 seconds)
- Level 1d ATMS on its native grid (96 samples per 8/3 second scan – i.e. same as the SDR, but with the microwave cloud products added)
- Level 1c MWTS and MWHS, and level 1d MWTS with mapped MWHS.
- Once MAIA v4 has been integrated into AAPP v7, an additional output product will be VIIRS mapped to CrIS, together with derived cloud products.

6. SYSTEM REQUIREMENTS

6.1 Language

As in previous versions of AAPP, the code will be written in FORTRAN77 (with agreed extensions), Fortran 90, C and C++. The code will be capable of compilation on a range of FORTRAN77, Fortran 90, C and C++ compilers. Some of the older library routines are in older versions of FORTRAN but these are compatible with the standard compilers. Fortran90 may be used for new modules, at the developers' discretion. Where the user elects to use a FORTRAN77 compiler, the build scripts will not attempt to build the Fortran 90 components (e.g. MAIA3).

Shell scripts will be either based on the Korn shell or based on Perl.

6.2 Supported platforms

The core AAPP has been installed and is currently supported on a range of UNIX-based platforms, including HP, SUN, SGI, DEC, IBM and PC (Linux). Some platforms may require minor code or configuration changes; these will be detailed in the installation guide.

The OPS-LRS has a more restricted set of platforms (see OPS-LRS User manual for details).

6.3 Performance

Examples of run times, for the various components of AAPP, will be provided in the Test Log. For those parts of AAPP where the code is essentially unchanged compared with AAPP v6, then the run times will not be significantly changed either.

6.4 Interface requirements

Where external libraries are required, AAPP v7 may rely only on free software libraries. These libraries will either be packaged together with the relevant sections of AAPP v7 (e.g. xerces and fftw are packaged together with OPS-LRS) or the user will be given instructions on how to download them from the Internet (e.g. the ECMWF BUFR library).

Interfaces with the ECMWF GRIB API library are required to be implemented in AAPP v7, replacing the interfaces with GRIBEX (which does not support GRIB 2).

6.5 Operational and resource requirements

The core of OPS-LRS is parallelized using POSIX threads. Therefore OPS-LRS requires a platform where POSIX threads are implemented. OPS-LRS requires at least 2Gb of memory and 1Gb of disk space to run its test cases. The remaining parts of AAPP are not expected to have any particular requirements that cannot be met by most modern workstations.

There may be additional system requirements for external packages such as IPOPP and IMAPP.

7. DOCUMENTATION

The AAPP scientific and technical documentation (including RD-1, RD-2, RD-3, RD-4 and RD-5) will be updated to include descriptions of the new capabilities.

On release of AAPP v7, the documents will be made available on the main AAPP web pages.

8. LIST OF REQUIREMENTS

This section details specific requirements to be addressed in the AAPP v7 Test Plan. Note that VIIRS processing (MAIA4 cloud mask) will be addressed as part of an AAPP v7 update release, so is not currently included in this section.

8.1 The Release Note accompanying the package shall list the contents of the package and how to unpack the software.

8.2 AAPP v7 should be successfully built, following the instructions in the Installation Guide. Where the user requires, it shall be possible to link external libraries to AAPP, including BUFR, GRIB API and HDF5.

8.3 The software should compile and run on a range of Unix platforms including Linux PC, Sun, AIX.

8.4 The existing NOAA and MetOp direct readout test cases for ATOVS, AVHRR and IASI shall run to completion, and shall have no unexpected differences between v6 and v7 in the

accuracy or coverage of the output products. Tolerances will be defined more fully in the Test Plan.

8.5 The existing test cases for MetOp BUFR and IASI principal components shall run to completion, and shall have no unexpected differences between v6 and v7 in the accuracy or coverage of the output products.

8.6 A test case for MAIA3 which includes GRIB2 forecast files is required, which should run to completion and give results compatible with the reference results from Météo-France.

8.7 AAPP v7 shall ingest the SDR files (HDF5) for ATMS and CrIS. The initial release of AAPP v7 will be tested using pre-launch simulated SDRs; modifications may be required to work with post-launch SDRs.

8.8 AAPP v7 shall ingest BUFR files for ATMS (sequence 310061) and CrIS (310060). The BUFR sequences are defined at http://www.wmo.int/pages/prog/www/WMOCodes/TDCFtables.html.

8.9 AAPP v7 shall implement user-configurable spatial filtering for ATMS, as described in [RD-7].

8.10 AAPP v7 shall implement user-configurable spectral filtering / thinning and spatial thinning for CrIS, as described in [RD-7].

8.11 AAPP v7 shall include the option to re-map ATMS to the CrIS fields of view.

8.12 The user may optionally BUFR encode the level 1d ATMS/CrIS output products, using a sequence devised for Met Office use.

8.13 Test cases shall be made available to users that exercise the functionality of 8.7 to 8.12.

8.14 AAPP v7 shall ingest the SDR files (HDF5) for the Chinese MWTS and MWTS instruments, and include the option to map MWHS to the MWTS grid. Derived products are not required.